

# NSW Threatened Species Scientific Committee

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## Conservation Assessment of *Bossiaea bombayensis* K.L.McDougall (Fabaceae)

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Biodiversity and Conservation  
Department of Planning and Environment

### ***Bossiaea bombayensis* K.L.McDougall (Fabaceae)**

Distribution: Endemic to NSW, near Braidwood

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Vulnerable

Proposed listing on NSW BC Act: Critically Endangered

Reason for change: Genuine change based on competition from weeds and loss of habitat following recent fire and repeated severe flood events.

### **Summary of Conservation Assessment**

*Bossiaea bombayensis* was found to be eligible for listing as Critically Endangered under Criterion B1ab(iii, v). The main reasons for this species being eligible are (i) it has a very highly restricted geographical range on the banks of the Shoalhaven River west of Braidwood (EOO is 20 km<sup>2</sup>), (ii) ongoing decline is inferred in habitat quality and availability because of competition from weeds, especially Scotch Broom, Blackberry, Willow and African Lovegrass, and (iii) ongoing decline is projected in population size and in habitat area and quality because of increased severity of floods from climate change.

### **Description and Taxonomy**

*Bossiaea bombayensis* K.L.McDougall (family Fabaceae), also known as Bombay Bossiaea, is a small, wiry shrub of the legume family. *Bossiaea bombayensis* is a recently described species (McDougall 2009). It was previously included within *Bossiaea bracteosa* sens. lat., a widespread taxon occurring on the Central and Southern Tablelands and South Coast of NSW, and in Victoria and South Australia (James and Harden 2002; McDougall 2009). Taxonomic research resulted in *Bossiaea bracteosa* sens. lat. being split into several new species, three of which are in NSW. *B. bracteosa* sens. strict. is now regarded as being a Victorian endemic (McDougall 2009). Conservation genomic work has confirmed that *B. bombayensis* is a phylogenetically distinct species (McMasters *et al.* 2022).

*Bossiaea bombayensis* K.L.McDougall was originally described by McDougall (2009). Thompson (2012) revised the *Bossiaea* of eastern Australia and described the species as "Erect rhizomatous leafless shrubs to c. 1.5 m high with cladodes to c. 5 mm wide, with inflorescences borne on both long and short cladodes, but not generally on a regular series of short side-branchlets; inflorescence-bearing cladodes sub-erect to erecto-patent, mostly 2–5 mm wide, not recessed at nodes or with recession to c. 0.7 mm deep, mostly soon glabrescent; marginal ridges poorly to moderately defined, mostly minutely uneven; new growth narrow-linear in profile, with scattered hairs adjacent to scales, and occasional hairs elsewhere along margins and sometimes also on faces; hairs occasionally persisting; epicuticular wax occasionally developing, lifting in flakes, with cladodes dark green or grey-green. Scales 1–1.5(–2) mm long, c. 0.5 mm wide from midrib to margin, brown, with venation obscure, with base sometimes minutely cordate. Inflorescences: axes contracted; scales 4 or 6, with largest 1.5–2 mm long, 1–1.5 mm wide; scale cluster 2–2.5 mm long; bract mostly caducous at

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anthesis, 2–3 mm long, c. 1.3 mm wide, strongly convex; pedicel 1.5–3 mm long, glabrous, not exceeding scale cluster or exceeding by up to 1 mm; bracteoles caducous before anthesis, c. elliptic, 2.5–3.2 mm long, with l:w ratio 1.5–2, appressed, inserted near base, strongly convex, with venation obscure, glabrous, brown. Calyx 3.5–4.5 mm long, glabrous, with tube longer than lobes; upper lobes triangular, 1–1.5 mm long, 1–1.2 mm wide, slightly acuminate, chartaceous distally; sinus 1–1.5 mm deep; lower lobes 1.5–2 mm long, chartaceous distally; lateral lobes 1 mm wide, at except for distal median ridge; median lobe slightly longer, wider and more convex than laterals; standard to c. 8 mm long, similar in length to wings and keel, adaxially yellow with a red are, abaxially largely suffused red but streakily pale medially and yellow towards lateral margins; wings 2.5 mm wide, brownish-red proximally, but largely yellow; keel 3.5 mm wide, grading from pale to pink to red; anthers c. 0.6 mm long post-dehiscence; ovary glabrous, 6–8-ovulate; style 3.5–4 mm long. Pods: stipe 1–2.5 mm long; body narrow-oblong, 20–26 mm long, 4–6 mm wide; upper margin 0.7–1 mm wide, at or with a fine sutural ridge to c. 0.3 mm high; valves with transverse venation obscure. Seeds 2–2.5 mm long, 1.3–1.5 mm wide; aril c. 1 mm long, c. 0.5 mm high, with base 0.6–0.8 mm long, with lobe curving c. 90° (Thompson 2012).

*Bossiaea bombayensis* can be distinguished from other taxa within *Bossiaea bracteosa* sens. lat. by the following features: from *B. fragrans* and *B. milesiae* by its equal to almost equal calyx lobes, from *B. bracteosa* by its much shorter, truncate leaf scales, and from *B. grayi* by its narrow, dark green cladode branches, smaller flowers and pods, alternating red and colourless staminal filaments, and general reddish appearance (of its flowers, new growth, calyx and pods) (McDougall 2009).

## Distribution and Abundance

The NSW Scientific Committee (2009) stated that “*Bossiaea bombayensis* is currently only known from the banks of the Shoalhaven River, west of Braidwood in the South Eastern Highlands Bioregion (Thackway and Creswell 1995).” The species’ range extends from Bombay to Warri.

*Bossiaea bombayensis* occurs on the traditional lands of the Yuin people who have a strong and ongoing cultural connection with their traditional lands and waters (AIATSIS 2022). Aboriginal Peoples have cared for Country for tens of thousands of years (Bowler *et al.* 2003; Clarkson *et al.* 2017).

Searches of potential habitat both upstream and downstream of the known occurrence have not led to the discovery of any further populations of *B. bombayensis* (McDougall pers. comm. March 2008 in Zimmer 2019, Appleby 2022). Most of the potential distribution of the species has been recently surveyed except along the west bank downstream from Bombay Creek (Appleby 2022).

*Bossiaea bombayensis* is not found in any conservation reserve. It grows mostly on private land, but also on WaterNSW land which includes the Bombay Reserve, Crown land and Travelling Stock Reserve (Appleby 2022).

The distribution of *Bossiaea bombayensis* is based on 60 unique records compiled from NSW BioNet Atlas, Atlas of Living Australia (ALA) and herbarium specimens and 39 records from survey results (M Appleby *in litt.* May 2022). A record 7 km north of Warri (ALA: CANB 875447.1) has been excluded from this data set as it is considered

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a mis-identification and targeted searches have not found *B. bombayensis* in this area (M. Appleby pers. comm. November 2022).

## Extent of Occupancy and Area of Occupancy

The Area of Occupancy (AOO) is 20 km<sup>2</sup> based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2022). The Extent of Occurrence (EOO) is calculated to be 9 km<sup>2</sup> based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022). However, where EOO is less than AOO then IUCN guidelines recommend EOO estimates be changed to be equal to AOO to ensure consistency with the definition of AOO as an area that fits within EOO (IUCN Standards and Petitions Committee 2019). As such, the EOO is also taken to be 20 km<sup>2</sup>. The calculated EOO (9 km<sup>2</sup>) is slightly lower than previous estimates (NSW Scientific Committee 2009) of 25-55 km<sup>2</sup>, which is a reflection of record accuracy rather than a population decline.

## Population size and trends

McDougall (2009) estimated the number of mature individuals of *Bossiaea bombayensis* as approximately 4,000-6,000 plants, based on field reconnaissance in the Shoalhaven Gorge (McDougall 2009). This estimate is likely to be of low data quality as it is not based on recorded survey data. Almost all the individuals of the species are located around Bombay with a 7 km gap (or 9 km along the river banks) to a small cluster of 58 individuals located at Warri (M. Appleby and V. Wong pers. obs. November 2023). In December 2019 a fire burnt 78% of the known habitat, including all of its known distribution except a 1km section of the river and a patchy burn in some areas. This fire killed mature adults and triggered mass recruitment of seedlings. A severe flood in February 2020, two months after the fire, uprooted and washed away an unknown number of unburnt mature adult plants, as well as soil containing seeds (Appleby 2022). Subsequent repeated severe flood events in 2020-22 washed away some mature *B. bombayensis* plants and many seedlings (Appleby 2022). A survey in 2022 recorded over 8,000 plants, of which 498 were mature (having survived the fire) and the rest were seedlings (94%), scattered across 33 sites along a 10.5 km stretch of the river (Appleby 2022).

There is not sufficient monitoring data to determine the proportion of the current cohort of seedlings that may survive to maturity to estimate a likely future mature population size. As such, the population size is considered to be in the same range 4000-6000 as estimated by McDougall (2009). Observations from one monitoring site suggest that the species occurred over a slightly greater extent pre-fire than post-fire, but numbers were not documented (Appleby 2022). However, the total number of mature individuals is inferred to have declined as a result of competition from weeds and loss of streambank habitat from scouring from repeated major flood events.

## **Ecology**

*Bossiaea bombayensis* is a wiry shrub that has only been found over a 16 km stretch of the Shoalhaven River in a steeply incised valley on sandy and rocky slopes and terraces above the frequent flood line of the river (McDougall 2009). It generally occurs in a narrow (<30m) strip between the riverbank and rocky slopes to the crest of the riparian area, although a few plants have been found above the crest just north of Bombay Bridge (Appleby 2022). A range of plant sizes has been observed, suggesting

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that recruitment is occurring more or less continuously and is not reliant on fire (McDougall 2009).

*Bossiaea bombayensis* occurs in shrubland vegetation and rarely extends into neighboring dry sclerophyll woodland (McDougall 2009). Associated species include *Callitris endlicheri*, *Grevillea arenaria*, *Lomandra longifolia*, *Micrantheum hexandrum*, *Pomaderris andromedifolia* and *Leptospermum polygalifolium* (McDougall 2009). The species is found in, but not restricted to, the Plant Community Type Southeast Tableland Rocky Riparian Scrub (PCT 4083) (Department of Planning and Environment 2023a).

*Bossiaea bombayensis* can reproduce from seeds produced from pollination or from root suckers (McMaster *et al.* 2022). It flowers in September and October with yellow and red pea flowers and the fruits dehisce by mid-December (McDougall 2009, Thompson 2012). Like most other members of the genus, flowers are pollinated by bees, wasps, beetles, and other insects (Bradbury *et al.* 2015; Stock 2019; Toon *et al.* 20014). Cross pollination can occur over many kilometres in species pollinated by bees (Beekman and Ratrieks 2001; Greenleaf *et al.* 2007; Smith *et al.* 2016). *Bossiaea bombayensis* has small seeds with an aril (Thompson 2012), suggesting ants may contribute to dispersal. Ants have been found to disperse seeds mostly less than 2m and rarely over 4 m (Westoby 1991). For this riparian species, floodwaters may also be important for seed dispersal, and in scarification (McDougall 2009).

*Bossiaea bombayensis* is a fire sensitive obligate seeder, with adults killed by fire followed by mass recruitment of seedlings (Appleby 2022). Fire is not required for regeneration, with seedling germination appearing to be a regular event (Appleby 2022; McDougall 2009). Unburnt monitoring plots at Bombay were found to have 16% seedlings (Appleby 2022). In burnt monitoring areas, 57% of the total number of individuals were seedlings that established in the years following the first post-fire germination event (Appleby 2022).

This species appears well-adapted to low soil moisture, with leaves reduced to cladodes and its ability to grow in rocky crevices exposed to light and heat with very little soil volume (Appleby 2022). The species did not appear impacted by the 2019 drought: unburnt monitoring plots had similar number of mature plants pre- and post-drought (Appleby 2022).

Genomic study of *B. bombayensis* found extremely low genetic diversity, suggesting this species is unlikely to be resilient to climate events or disease and may be prone to inbreeding depression (McMasters *et al.* 2022).

Based on the potential for pollination and seed dispersal by floodwaters to occur over many kilometres, and on genetic information (McMasters *et al.* 2022), all records of *Bossiaea bombayensis* are considered to be part of a single population (= 1 subpopulation for IUCN Criterion C), with the majority of individuals located on the banks of the Shoalhaven River around Bombay and a smaller cluster of individuals located 9 km to the north along the river at Warri.

*Bossiaea bombayensis* has been observed to reach maturity in 2-4 years (Appleby 2022). The longevity of individual plants is unknown and generation length has not been calculated.

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## Threats

The main threat to *Bossiaea bombayensis* and its habitat continues to be competition from weeds, especially Scotch Broom *Cytisus scoparius*, Willows *Salix* spp., Blackberry *Rubus discolor* spp. agg. and African Lovegrass *Eragrostis curvula* (Appleby 2022; NSW Scientific Committee 2009). There is also some human disturbance from visitors at a small recreation reserve at Bombay, a camping area at Warri (Appleby 2022) and a large sand quarry 1.5 km upstream from Warri. Additionally, *B. bombayensis* is mostly found on private land, which contributes to difficulty in effectively managing threats, particularly weeds and human impacts.

### Competition from weeds

The main threat to *Bossiaea bombayensis* is weed invasion, especially Scotch Broom *Cytisus scoparius*, Willows *Salix* spp., Blackberry *Rubus discolor* spp. agg. and African Lovegrass *Eragrostis curvula* (Appleby 2022; NSW Scientific Committee 2009). In addition, local occurrences of Serrated Tussock *Nassella trichotoma*, Gorse *Ulex europaeus*, Pine trees *Pinus* spp., Fleabane *Conyza* spp., Mullein *Verbascum* spp., Ribwort *Plantago* spp., Purple Top Vervain *Verbena bonariensis*, Spear Thistle *Cirsium vulgare* and Cats Ears *Hypochaeris radicata* may also threaten the species (Appleby 2022; NSW Scientific Committee 2009).

In its 2009 Final Determination, the NSW Scientific Committee (2009) stated that “These weeds are widespread but, at present, rarely dominate the local vegetation in this area” and that “Although parts of the habitat are affected, weeds are not currently considered to be causing decline in *Bossiaea bombayensis* (McDougall pers. comm. March 2008).” The assessment concluded that the current weed situation suggested decline in the quality and availability of habitat of *B. bombayensis* (NSW Scientific Committee 2009).

Since the fire of 2019 and subsequent repeated major floods, the impact of weeds on the population of *Bossiaea bombayensis* has changed. Weed infestations on the banks of the Shoalhaven River in, and adjacent to, the known habitat of *B. bombayensis* are severe and extensive (Appleby 2022, V. Wong pers. obs. November 2022). Dense thickets, tens to hundreds of metres long and 5 to 30 m wide along the river banks, of predominantly Scotch Broom and Blackberry, grow adjacent to known *B. bombayensis* habitat, preventing the species from colonising these areas (M. Appleby and V. Wong pers. obs. November 2022). Less dense, but spreading, invasions of these weeds occur in rockier areas, causing a considerable ongoing decline in the quality and availability of habitat. Ongoing decline is inferred in the population size from competition from weeds.

However, weeds, such as African Lovegrass tussocks, can act as a nursery for emerging *B. bombayensis* seedlings, providing shelter and a moist-micro habitat (M. Appleby 2022).

Occasional weed control is conducted by the Queanbeyan-Palerang Regional Council at the small Bombay Reserve (M. Appleby *in litt.* June 2023), but it does not address weeds in the majority of the species’ habitat area.

### Increased severity of floods as a result of climate change

While floods are a regular feature of the habitat of *Bossiaea bombayensis*, the timing of repeated severe flood events just over two months after the 2019 fire and through

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the following months, has killed unburnt adult plants, scoured away a large amount of riverbank soil (and presumably seeds and seedlings), deposited localised large piles of flood debris and covered other areas in mud and sand (Appleby 2022). The repeated large floods have eroded the width of the banks within the river corridor (M. Appleby *in litt.* April 2022). As such, bank erosion, in combination with dense *Acacia* regrowth up slope from the river in areas affected by fire, has effectively limited the extent of post-fire establishment and habitat of *B. bombayensis* (M. Appleby 2022).

The intense La Nina events of 2020-22 highlight the vulnerability of the species to major repeated flood events, which are predicted to increase in intensity with climate change (BOM 2022). As such, continuing decline in the species is projected from increased severity of floods from climate change. 'Anthropogenic climate change' is listed as a Key Threatening Process under the BC Act.

## High Frequency Fire

If another fire should occur in the next couple of years before the current cohort of seedlings matures, population reductions may occur. Short time intervals between fires in obligate seeders can disrupt the replenishment of seed banks, which are essential to post-fire recruitment and population persistence (Enright *et al.* 2015; Gallagher *et al.* 2020; Zimmer *et al.* 2021). However, *B. bombayensis* grows in an area where there is no history of fire prior to the 2019 fire (Department of Planning and Environment 2023b). As such, frequent recurrent fire in habitat of *B. bombayensis* is highly unlikely under projected changes to fire conditions under ongoing climate change (Abatzoglou *et al.* 2019; AdaptNSW 2023; Bowman *et al.* 2020). Fire risk may be increased by camping and/or campfires at Warri and in the Bombay Reserve (M. Appleby *in litt.* June 2023)

## Disturbance from visitor recreation and road maintenance

The Shoalhaven River Bombay Reserve is a significant place of recreation for local residents (McDougall 2009) and *Bossiaea bombayensis* may be trampled and disturbed at this site. Several mature plants were recently killed during maintenance works on the road adjacent to this reserve (Appleby 2022). Recent survey of the very small Warri site also showed disturbance from campers and caravanners (Appleby pers. obs. November 2022).

## Habitat degradation from feral pigs and deer

Feral pigs *Sus scrofa* and feral deer are a potential ongoing threat to *Bossiaea bombayensis*. Feral pigs and Sambar Deer *Rusa unicolor* have a particular affinity for wet areas of the landscape, which they use for feeding and wallowing (Bengsen *et al.* 2014; Forsyth *et al.* 2009). Domestic stock, feral cattle, feral deer and feral pigs can cause damage to riverbanks including vegetation removal, soil disturbance and increased turbidity. Trampling by pigs was observed during recent surveys in habitat of *B. bombayensis* (Appleby 2022).

## Disease

Recent surveys found that adult plants and seedlings were discoloured and showing signs of disease in several patches and dead unburnt plants were noted in some sites (Appleby 2022), however the cause of the dieback is unknown. *Bossiaea bombayensis* may be susceptible to the introduced pathogen *Phytophthora cinnamomi*, as other *Bossiaea* species are strongly suspected to be adversely affected (NSW Scientific Committee 2003). *Phytophthora cinnamomi* has had a devastating effect on plant

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communities world-wide, causing catastrophic dieback in many species. The risk of *Phytophthora* is increased by visitation at Bombay Reserve and Warri and potentially could be introduced from upstream sources. 'Infection of native plants by *Phytophthora cinnamomi*' is listed as a Key Threatening Process on the BC Act.

## Damming of the Shoalhaven River

Although not currently in planning, damming of the Shoalhaven River (such as the currently shelved Welcome Reef proposal) may pose a future threat to *Bossiaea bombayensis*, and could affect about 80% of suitable habitat for the species (K. McDougall pers. comm, in NSW Scientific Committee 2009).

## **Assessment against IUCN Red List criteria**

For this assessment it is considered that the survey of *Bossiaea bombayensis* has been adequate and there is sufficient scientific evidence to support the listing outcome.

*Criterion A*                      *Population Size reduction*

Assessment Outcome: Data Deficient

Justification: To be listed as threatened under Criterion A the species must have experienced a population reduction of  $\geq 30\%$  over three generations or 10 years (whichever is longer). There is insufficient data to assess *Bossiaea bombayensis* against this criterion because the generation time is unknown and there is no long-term monitoring data.

*Criterion B*                      *Geographic range*

Assessment Outcome: Critically Endangered B1ab(iii, v)

Justification: *Bossiaea bombayensis* has a very highly restricted geographic range with both the Extent of Occurrence (EOO) and Area of Occupancy (AOO) 20 km<sup>2</sup>. *Bombay bombayensis* meets the EOO threshold for Critically Endangered (<100 km<sup>2</sup>) under Criterion B1. The AOO meets the threshold for Endangered (<500 km<sup>2</sup>) under Criterion B2 but is above the threshold for Critically Endangered (<10 km<sup>2</sup>).

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

- a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR),  $\leq 5$  (EN) or  $\leq 10$  (VU) locations.

Assessment Outcome: Met for Critically Endangered

Justification: *Bossiaea bombayensis* has one location based on the most serious plausible threat of competition from weeds, especially Scotch Broom, Blackberry, Willow and African Lovegrass. The species occurs in a single population along a 16 km stretch of the Shoalhaven River, with a gap of approximately 7km (or 9 kilometres along the river) between the majority of current individuals at Bombay and a smaller cluster of plants at Warri. Since the 2019 fire, the riverbanks have become extensively colonised by weed species, including thickets of Scotch Broom and Blackberry.

The population and habitat of *Bossiaea bombayensis* do not meet the definition of severely fragmented as the majority of the AOO is in a single habitat patch.

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- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: Subcriterion met for Critically Endangered B1ab (iii,v)

Justification: Continuing decline is inferred in the quality of habitat from competition from weeds, particularly Scotch Broom, Blackberry, Willow and African Lovegrass. The first two of those species have been identified as Weeds of National Significance, because of their invasiveness, potential for spread, and economic and environmental impacts (Department of Primary Industry 2023). Continuing decline in habitat area and quality is inferred from increased severity of floods as a result of climate change causing loss of areas of riverbank. Continuing decline in the number of mature individuals is inferred as a result of increased severity of floods and competition from weeds.

- c) Extreme fluctuations.

Assessment Outcome: Data Deficient.

Justification: Currently there is no available data to assess the likelihood of extreme fluctuations in *Bossiaea bombayensis*.

*Criterion C Small population size and decline*

Assessment Outcome: Vulnerable under C2a(ii)

Justification: The estimated population size of *Bossiaea bombayensis* is 4,000-6,000 plants (Appleby 2022, NSW Scientific Committee 2009), which meets the threshold for Vulnerable (<10,000 mature individuals) but exceeds the threshold for Endangered (<2500 mature individuals). In addition, 100% of mature individuals occur in one subpopulation.

At least one of two additional conditions must be met. These are:

- C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generation (whichever is longer) (CR); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Data deficient

Justification: There is insufficient data to assess *Bossiaea bombayensis* against this subcriterion.

- C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: Subcriterion met

Justification: Continuing decline is inferred in the number of individuals from competition from weeds, particularly Scotch Broom, Blackberry, Willow and African Lovegrass and from loss of habitat from increased severity of floods as a result of climate change.

In addition, at least 1 of the following 3 conditions:

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- a (i). Number of mature individuals in each subpopulation  $\leq 50$  (CR);  $\leq 250$  (EN) or  $\leq 1000$  (VU).

Assessment Outcome: Subcriterion not met

Justification: The species is considered to occur in a single population of 4,000 to 6,000 individuals, which does not meet the threshold of  $\leq 1,000$  to be listed using this Subcriterion.

- a (ii). % of mature individuals in one subpopulation is 90-100% (CR); 95-100% (EN) or 100% (VU)

Assessment Outcome: Vulnerable under C2a(ii)

Justification: *Bossiaea bombayensis* has only one subpopulation.

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data deficient

Justification: Currently there is no available data to assess the likelihood of extreme fluctuations in *Bossiaea bombayensis*.

*Criterion D*      *Very small or restricted population*

Assessment Outcome: Vulnerable under D2

Justification: *Bossiaea bombayensis* does not meet Subcriterion D1 because its population size of 4,000-6,000 is over the threshold of 1,000 mature individuals. The species meets the Subcriterion D2 because it has an AOO of 20 km<sup>2</sup> and one location, and a plausible future threat of a dam on the Shoalhaven River that could drive the species to extinction.

To be listed as Vulnerable under D, a species must meet at least one of the two following conditions:

- D1. Population size estimated to number fewer than 1,000 mature individuals

Assessment Outcome: Not met.

Justification: The total number of mature *Bossiaea bombayensis* individuals is estimated to be 4,000-6,000 and therefore the species does not meet the threshold for listing under Criterion D1.

- D2. Restricted area of occupancy (typically <20 km<sup>2</sup>) or number of locations (typically <5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: Vulnerable D2

Justification: *Bossiaea bombayensis* has an AOO of 20 km<sup>2</sup> and one location, and a plausible future threat of a dam on the Shoalhaven River that could drive the species to extinction. On this basis the species meets the threshold for listing as Vulnerable under Criterion D2.

*Criterion E*      *Quantitative Analysis*

Assessment Outcome: Data Deficient

Justification: Currently there is not enough data to undertake a quantitative analysis to determine the extinction probability of *Bossiaea bombayensis*.

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## Conservation and Management Actions

*Bossiaea bombayensis* is currently listed on the NSW *Biodiversity Conservation Act 2016* and a conservation project has been developed by the NSW Department of Planning and Environment under the Saving our Species program. The conservation project identifies priority locations, critical threats and required management actions to ensure the species is extant in the wild in 100 years. *Bossiaea bombayensis* sits within the Site Management stream of the SoS program and the conservation project can be viewed here:

<https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20125>

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## APPENDIX 1

### Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

#### Overall Assessment Outcome:

*Bossiaea bombayensis* was found to Critically Endangered under Clause 4.3 (a) (d) (e i, iii)

#### Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

Assessment Outcome: Data deficient

<b>(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:</b>			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size.
<b>(2) - The determination of that criteria is to be based on any of the following:</b>			
	(a)	direct observation,	

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	(b)	an index of abundance appropriate to the taxon,
	(c)	a decline in the geographic distribution or habitat quality,
	(d)	the actual or potential levels of exploitation of the species,
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

### Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

**Assessment Outcome: Critically Endangered under Clause 4.3 (a) (d) (e i, iii)**

<b>The geographic distribution of the species is:</b>			
	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
<b>and at least 2 of the following 3 conditions apply:</b>			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,
		(iv)	the number of locations in which the species occurs or of populations of the species,
	(f)	extreme fluctuations occur in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	the number of locations in which the species occur or of populations of the species.

### Clause 4.4 - Low numbers of mature individuals of species and other conditions (Equivalent to IUCN criterion C)

**Assessment Outcome: Vulnerable under Clause 4.4 (c)(e ii, B)**

<b>The estimated total number of mature individuals of the species is:</b>				
	(a)	for critically endangered species	very low, or	
	(b)	for endangered species	low, or	
	(c)	for vulnerable species	moderately low,	
<b>and either of the following 2 conditions apply:</b>				
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):		
		(i)	for critically endangered species	very large, or
		(ii)	for endangered species	large, or
		(iii)	for vulnerable species	moderate,
	(e)	both of the following apply:		

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		(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and		
		(ii)	at least one of the following applies:		
		(A)	the number of individuals in each population of the species is:		
			(I)	for critically endangered species	extremely low, or
			(II)	for endangered species	very low, or
			(III)	for vulnerable species	low,
		(B)	all or nearly all mature individuals of the species occur within one population,		
		(C)	extreme fluctuations occur in an index of abundance appropriate to the species.		

## **Clause 4.5 - Low total numbers of mature individuals of species**

**(Equivalent to IUCN criterion D)**

**Assessment Outcome: Not met**

<b>The total number of mature individuals of the species is:</b>					
		(a)	for critically endangered species	extremely low, or	
		(b)	for endangered species	very low, or	
		(c)	for vulnerable species	low.	

## **Clause 4.6 - Quantitative analysis of extinction probability**

**(Equivalent to IUCN criterion E)**

**Assessment Outcome: Data deficient**

<b>The probability of extinction of the species is estimated to be:</b>					
		(a)	for critically endangered species	extremely high, or	
		(b)	for endangered species	very high, or	
		(c)	for vulnerable species	high.	

## **Clause 4.7 - Very highly restricted geographic distribution of species–vulnerable species**

**(Equivalent to IUCN criterion D2)**

**Assessment Outcome: Vulnerable under Clause 4.7**

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.
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